Adult Soapbox Kart

Written By: Jeremy Ashinghurst

TOOLS:

- Angle grinder (1)
- Belt Sander (1)
- Brake (1)
- Caliper (1)
- Chop saw (1)
- Conduit Bender (1)
- Countersink (3)
  3/8", 1/2", 3/4"
- Drill bits (12)
  drill bits required for this project: 3/32", 1/8", 1/4", 5/16", 3/8", 1/2", 5/8", 3/4", #7, #3, Q, I
- Drill press (1)
- Hole Saws (3)
  3/4", 1", 1-1/4"
- Hydraulic Tube Bender (1)
- Lathe (1)
- Milling machine (1)
- Phillips 2 Screwdriver (1)

PARTS:

- Azusa 5" nylon wheel (4)
  #1057
- Azusa Ribbed Tire (4)
  #7164
- Azusa Inner Tube (4)
  #7131
- Azusa Brake Platform (2)
  #2259A
- Azusa brake shoes (2)
  #2270A, Straight Lever
- Azusa Brake drums (2)
  #2211-ID
- Azusa Throttle Pedal (1)
  #1811
- Azusa Brake cable (2)
  #2331
- Azusa Cable Conduit (2)
  #2322-60
- Azusa Cable Clevis (2)
  #2366

- Portable Drill (1)
- Rivet gun / rivets (1)
- Separating Tool (1)
- Side/End Mills (3)
  3/4", 1", 1-1/4"
- Tap (7)
  taps required for this project: 1/4-20, 1/4-28RH and LH, 5/16-24, 3/8-16, 3/8-24RH and LH
- Tape measure (1)
- Tin snips (1)
- Tubing Notcher (1)
- Welding, either wire welder or gas welder. (1)
- Wrenches (5)
  7/16", 1/2", 9/16", 5/8", 3/4"
- Azusa Conduit Retainer (2)
  #2372
- Azusa Wire Stop (2)
  #2360
- Azusa Shock Absorber (4)
  #1700-128
- quick release steering hub (1)
  Wilwood #950-270-2016
- 5-point racing harness (1)
- 3/4" Bearing (2)

SUMMARY

This guide will teach you the basic design aspects you'll need to consider in order to make yourself a road-worthy gravity-powered vehicle. Full suspension on go-kart wheels, driver restraints, a rigid frame with roll bar, and balanced drum brakes are features of the example kart I've built. It weighs in at under 100lb.

Original build thread

Full Photoset

A variety of vehicles that may be built using the principles in this guide

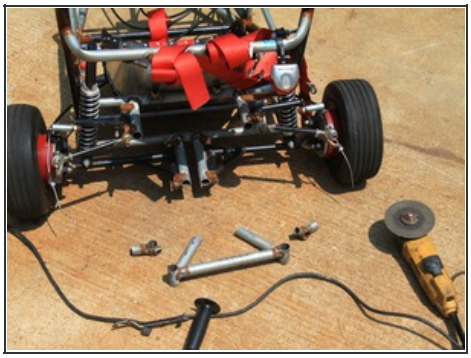
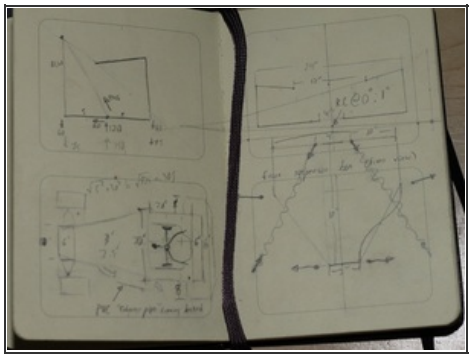
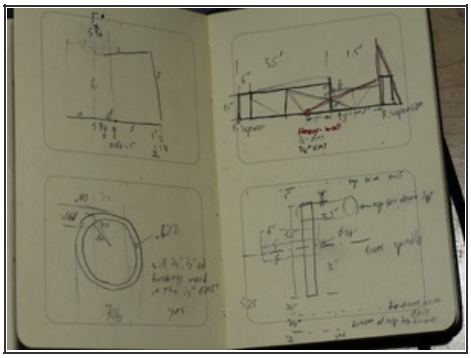
You may, however, use the information in this article to make your own kart that looks different or incorporates some different features, as do the large variety of karts in the video above. This guide assumes basic experience with a wide variety of metalworking tools.

Step 1 — Adult Soapbox Kart



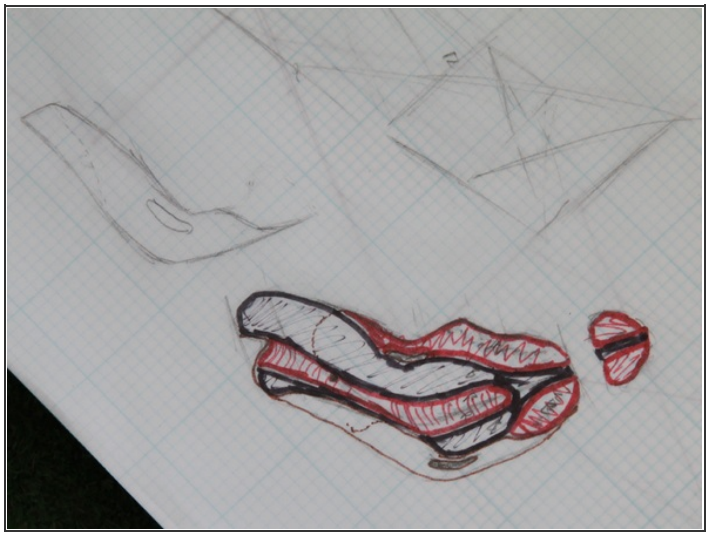
- Creating a full-suspension soapbox kart capable of highway-speed travel from raw parts & materials is a monumental undertaking.
  - My kart in its current state represents a total time investment of around 300 hours over the course of a year and the current configuration uses approximately $600 worth of parts and materials.
  - Think of this as doing your part to stimulate the economy and keep yourself off the couch. The sheer breadth of tools required to build it will leave you proud of your hard work as you roll down nearby hills in your super-cool soapbox kart.
- Before starting to build karts 2 years ago, I had no experience in metalworking.

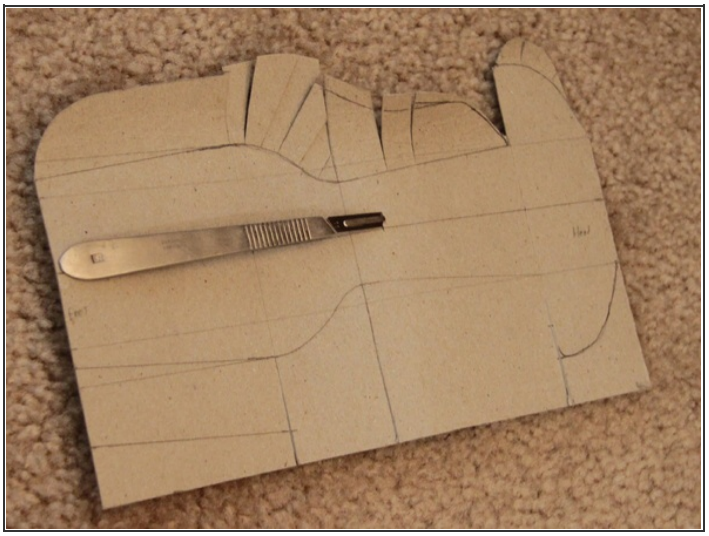
Step 2 — Prep

- You may want to jump into this project with wild, reckless abandon and that's OK, but you may also be the kind of person to plan everything out.
- What I recommend is to make drawings (detailed ones) of your frame and suspension components, make cut lists for all your materials so you know how much to order (50% more than you think you may conceivably want), and share your designs with other people who might be able to guide you.
- I recommend a Moleskine and the book *How to Make Your Car Handle*. While it's an old book, it is readable and well-suited to this project.

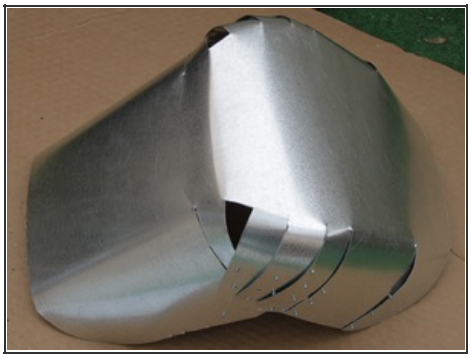
Step 3 — Seat intro and mock-up





- Of all the parts to make first, I chose the seat. Not the frame, the wheelbase, suspension parts, etc.; the seat. The thinking was that it would give me something to sit in while I test-fitted everything around me.
- The way I made a seat was as a single sheet of thin metal that was cut and riveted to form a 3-dimensional object. It should be concave, and if you want it to have convex bends in it you must use more than one piece of metal.
- To work out the basic shape for the seat, start with a piece of paper. Draw the centerline of the seat and trace an approximate outline of your body; that will be the back/bottom. From there, draw lines perpendicular to your body outline toward the edge of the paper. Cut along these lines and that's what will allow the center portion to bend to your body.

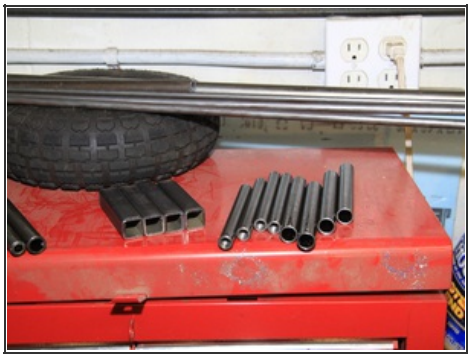
Step 4 — Actual Seat



- For the real seat, do the same process as the mock-up, but with sheet metal instead of paper and rivets instead of tape. Clamps are handy to hold things in place while you drill holes for the rivets.
- If the edges are too sharp, feel free to attach upholstry to your seat; I used some black and red cloth-backed pleather from a fabric store.
  - I held it on by riveting on some extra scraps of metal on top of the fabric.
  - My upholstered seat has held up to 8 months of sun, rain, and snow so far...

Step 5 — Materials Selection





- You may make your soapbox kart out of anything you want! Steel, aluminum, fiberglass, carbon fiber, wood, anything!
- Make sure that you make it strong enough to keep you as protected as you need to be for your intended use.
  - We have a wooden kart that was made for more traditional quarter-mile, straight, head-to-head soapbox racing but nobody has been brave enough to try it on the open road.
- Also consider ease of construction/modification. For frames, metals are easier to start working with and modify than composites like fiberglass.
  - Expect to have to modify your kart. My kart has gone through several changes as I've built it so it needs to be modifiable.
- My kart was made with 1" and 1-1/4" black pipe, plus 1/2" and 3/4" EMT from Lowe's. Both are steel and thus can be MIG welded with ease.
  - A kart intended for really rough hills or high-speed races should be made to be more sturdy than lightweight. I would suggest using larger sizes of EMT or switching it out for equivalent sizes of black pipe.

Step 6 — Frame members



- Straight frame members are pretty simple.
  - Cut them to the proper length either straight with a chop saw or, to make welding easier, fish-mouthed with a tubing notcher or milling machine.
  - If you are making fish mouths, make sure to double-check your intended length.

Step 7 — Bending frame members

- Frame members made out of EMT or other lightweight tubing can be easily bent using a hand bender from Home Depot.
- Heavy pieces that need to be bent require a hydraulic bender.
- Pieces I bent using the hand bender: the upper frame rails, the rear shoulder harness crossmember, and the upper crossmembers that hold the steering shaft bearings.
- Only one piece on this kart required bending in a hydraulic bender: the rollbar
  - Rather than just make one tight bend on the rollbar, I opted to go for one central bend and two side bends. It didn't turn out nearly as symmetric as I had hoped, but my subsequent attempts have been better.

Step 8 — Assembling the frame



- Weld together the frame in accordance with whatever material you have chosen
  - If, like me, you're mostly working with EMT, make sure to sand down the areas you're going to weld since the galvanization on the tubing degrades the quality of your welds.
  - Use a thicker, stronger material for the frame members surrounding the body of the driver. In my kart the rollbar, a pair of side bars, and a bottom crossbar are all made out of heavy-duty steel pipe rather than wimpy 1/2" EMT.
  - Once your frame is fully together, don't cut or drill anything out of it as this will make it weaker. If you have to attach things to your frame then weld on tabs or tube stubs and attach to those.
  - Give it a test fit. Be sure to make car engine noises to pretend you're going fast!

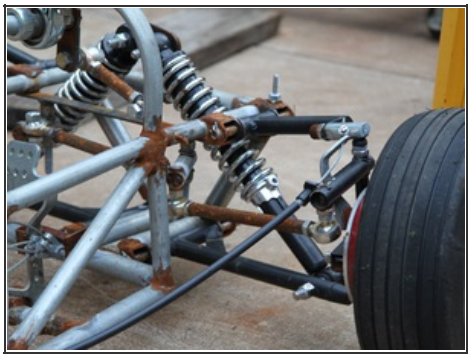
Step 9 — Wheel selection



- Your wheel selection will determine what sort of road your kart does best on.
- Flat profile tires (especially at lower pressures) offer a larger contact patch and grip but have relatively high rolling resistance. They may handle well in corners but will not accelerate as well or have a high top speed.
- Round profile tires (especially at higher pressures) have very low rolling resistance but have smaller contact area. They will reach higher top speeds but may slide easier under tight cornering.
- Tall wheels like bicycle wheels will not have to rotate as fast as go-kart wheels at a given kart speed, but are more prone to folding under extreme cornering loads or bumps.

Step 10 — Full suspension or rigid frame?





- Foregoing suspension will mean lower weight, complexity, and cost.
- The benefits of suspension are comfort and coolness. In my experience, handling and speed are a wash between the two options.
- If you make suspension, you must make it well or it will hurt the kart's handling and speed. My first iteration severely impacted my cornering ability.
- Your suspension must have as little slop and unpredictability as possible. Use only high-quality parts and materials, double-check all your measurements, and make sure your welds are good.
- Do NOT use the inline ball-joint linkages shown in the upper right of image 2. They have too much play for a suspension system, and were replaced shortly after this picture was taken.

Step 11 — Lower suspension members



- These lower members really need to be beasts. they'll have the shocks attached to them so they're bearing the load of the entire kart. Even if you're going for a lightweight kart, don't skimp here.
- Tube-end weld nuts serve as the attachment point for the spindle-end ball joint, and a pair of bushings will rotate about a 3/8" rod attached to the frame. This allows the arms to swing up and down but not side-to-side.
- Gussets help absorb the stress on the frame end welds.
- For the rear suspension, the shocks are mounted on tabs above the member. For the front, shocks are mounted directly to the suspension members.

Step 12 — Upper suspension members

- The suspension I use on all 4 corners is unequal-length A-arm. The top arm is shorter than the bottom arm so the wheels will show negative camber at bump and positive camber at droop.
  - This keeps the wheels perpendicular to the road under cornering to maximize the contact patch. If you're using round-profile tires, equal length A arms will be easier.
- The shocks aren't attached to the upper arms so they won't be bearing much load in any direction besides compression. I felt free to make these lightweight and not very strong: the main arm is 1/2" EMT.
- Higher-quality steel tube at the frame end allows for precision bushings, and a 3/8-24 ball joint attaches to the spindle end for suspension articulation as well as steering/alignment.

Step 13 — Mounting suspension to the frame



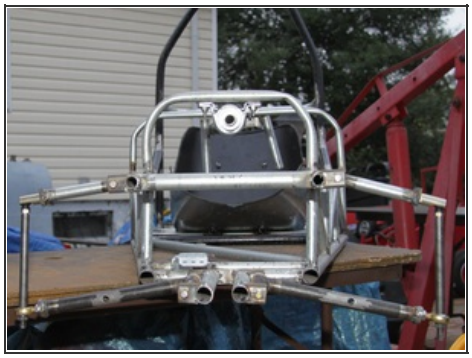
- I mounted the suspension to the frame using 3/8" rods with bushings on the suspension members.
- Except for the top rear arms (pictured in middle image), the 3/8" rods are held to the frame via simple cotter pins.
- Shocks are attached to the frame via welded-on studs. Be careful when working out suspension placement; it can get very crowded with arms, shocks, tie rods, wheels, the frame, etc.

Step 14 — Spindles



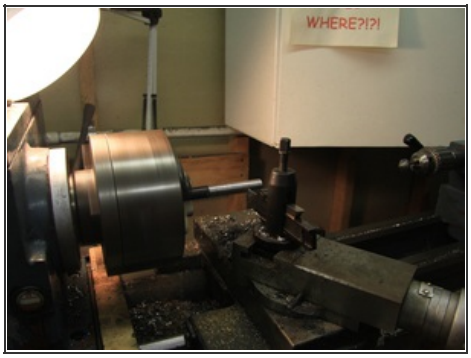
- The spindles are the thing that brings your suspension together. They connect the upper and lower arms, hold the wheels and the brakes, attach to the steering system, and are the single biggest pain in the butt about this project, especially if you're trying to minimize weight like I am.
- Some go-kart suppliers sell ready-made spindles for karts with brackets that weld directly to the frame. If you've opted for no suspension, these are probably a good idea as spindles are the component I find myself revising the most often.
- If you do opt to make spindles yourself, there are 3 or 4 parts you will have to make: kingpin (vertical element that is the axis of rotation when turning), axle (for the wheel), drag link arm (for turning/alignment), and (optionally) mounting points for brake hardware.

Step 15 — Spindles, continued



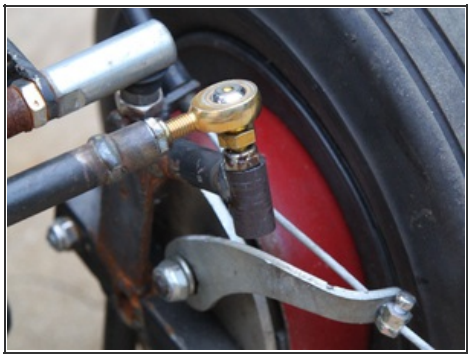
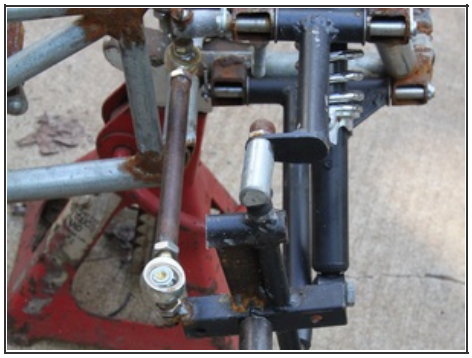

- Be careful what materials you choose for the kingpin and the axle, as they must be sturdy enough to support the weight of the kart under stress, even if you have suspension. Use your most precise tools when drilling holes for spindle parts, as they must all be at the correct angles or steering/suspension geometry will be off.
- To accentuate the camber change of the unequal length A-arm suspension, use a total kingpin length slightly greater than the height difference between the upper and lower suspension mount points on your frame.
- Here you'll need to tap some threads into the ends of the kingpin for the ball joints to thread into. I used a 3/8-24 ball joint on top and a stronger rod end on the bottom which I attached via a 3/8-16 fully-threaded stud.
- If you have to tap two different thread sizes, be sure not to confuse top and bottom.

Step 16 — Spindles, continued: Axle



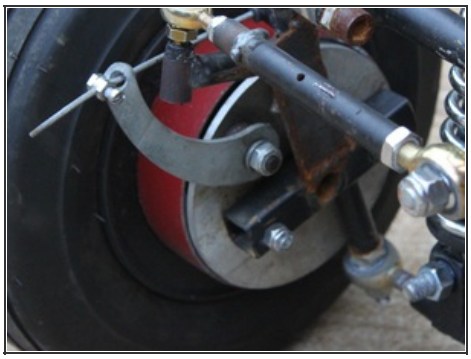
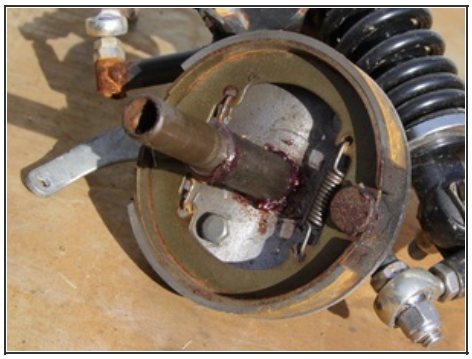
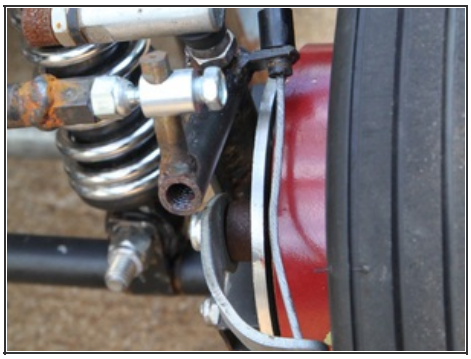

- If you ordered some sort of tube to use as your axle, it may be a little too big for your application. (If you ordered solid, precision axle material you're probably OK.) Test your wheels to make sure they fit on and, if not, do the following:
  - Before you weld your axle material into the spindle, turn it down on the lathe and make sure your wheels fit onto the axle without (too much) difficulty. If you take off too much material, however, the wheels will be loose.
- To hold the wheels on the axle you may use one of two things: a cotter pin or a nut. A cotter pin simply requires a hole drilled through the end of the axle, but may require shimming to eliminate lateral wheel travel. A nut requires that threads be cut into the axle with a die, but allows you to eliminate wheel travel without shims.
  - I used a cotter pin for the lighter weight, the simplicity, and the fact that my axle tube has a rather thin wall and might not hold up too well once threads were cut.

Step 17 — Spindles, continued: Drag link

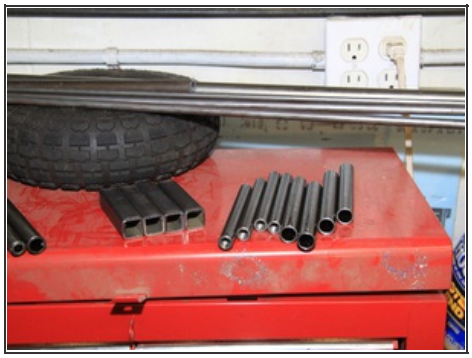
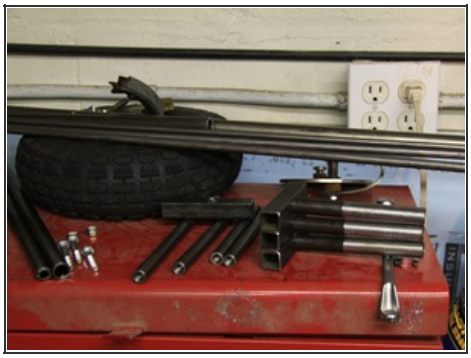

- Wherever you vertically position your drag link arm, there must be another mount at the corresponding height and location on your frame if you are to avoid bump steer (again, see *How to Make Your Car Handle*). Note the rightmost picture.
- Make sure the drag links are reinforced well: I had problems with the drag link arm twisting on big bumps until I welded some gussets on it. Eventually the front drag links became part of the original brake backing plate, a much more sturdy piece of hardware.

Step 18 — Spindles, continued: Brake mounts

- For a kart this lightweight and with such a high percentage of weight on the rear axle, drum brakes on the rear wheels stop this kart very well.
- The brakes are mounted onto the axle and secured with two 1/4-20 bolts to the brake mounting bar, which is 3/4" square tube.
- in order to make sure the wheels maintain their proper position, once the brakes are on you will need to put a spacer over the axle. This spacer will keep the inner wheel bearing from wandering too far inward during cornering.
- The other addition the spindle will need is a tab with a hole in it where the cable conduit will end. It doesn't need to be anything special.

Step 19 — Spindles, continued: Putting it all together

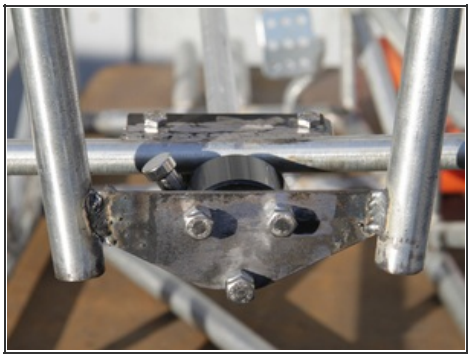
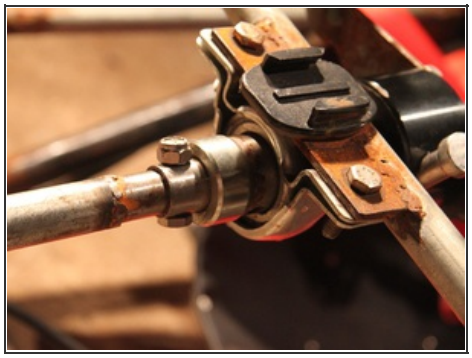
- In my application, since I am using drum brakes on the rear and nothing on the front, my rears have the kingpin, axle, and horizontal brake mounting bar all intersect at the axle level. The drag link arm for wheel alignment is at the top of the spindle.
- My front spindles have the kingpin, axle, and drag link arm for steering all intersect at the axle level.
- When you weld it all together, use jigs and measure the angles of everything to be sure you're getting it right.

Step 20 — Brakes



- When routing cable for your brakes, using cable housing is a trade-off. It is easier to use one long run of cable housing than to break it into multiple runs, but friction from the guide as well as compression in the guide will reduce braking power and feel.
  - Where possible, brake cables should be routed as straight as possible and with as little cable guide as possible.
- A balance bar makes sure that both sides of the kart get equal braking force so you don't feel a pull to one side when braking. A balance bar can be just a piece of bar stock with 3 holes drilled in it, with one hole directly between the other two.
  - It's easiest to put the balance bar right on the brake pedal, with the braking cable attached to either end of the balance bar and the central pivot rotating on a pin attached to the pedal.
- Where possible, use brakes that mount easily to your wheels. These Azusa drums mount directly to the wheels through a bolt-extension platform.

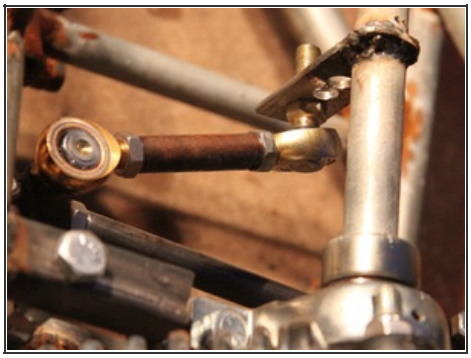
Step 21 — Steering: wheel and shaft


- If your kart is going to be cramped for space like mine, a quick-release steering wheel hub is the best option for easy entry.
  - simply press the button on the left of the black hub, and the wheel pops right off.
- A steering yoke can be as simple as a BMX handlebar riser or two pieces of tube welded to a plate of metal. As long as it fits and works, there's not much to be picky about. One of our drivers uses a decades-old minivan wheel and loves it.
- The steering shaft must be held on in two places, and I've found that pillow block bearings are the easiest way to do this, though others in my group have used large-sized rod ends.
  - Note the bolt that goes through the steering shaft in the middle picture. The shaft separates into two pieces for (relatively) easy removal.
- The steering shaft should have a Pitman arm, which is the part that attaches to the rest of the steering system and causes the wheels to turn. Alternately, you may use a steering rack. I do not recommend rope steering as on children's soapbox karts.

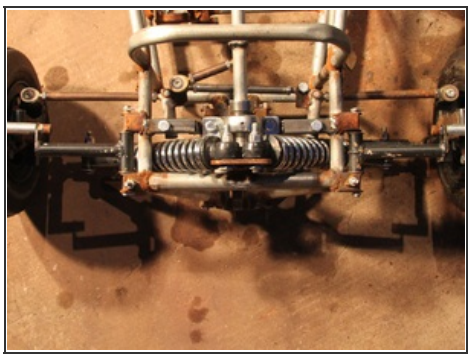
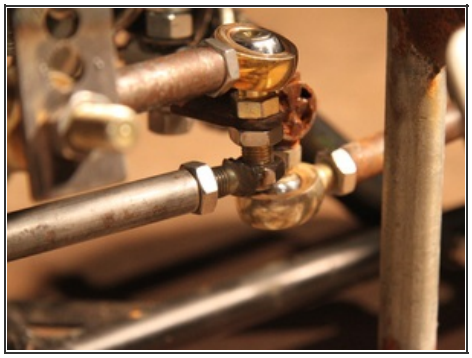
Step 22 — Steering: Tie rods





- To make your steering adjustable, you need tie rods with threaded sections on either end and rod ends to attach to.
  - Making the threading right-handed on one end and left-handed on the other end allows you to lengthen/shorten the tie rod without removing it from the kart.
- Measure and cut the tie rods to exact lengths. if you have a lathe, make sure the ends are as flat and square as possible so your tightening nut will have a good surface to mate to and won't slip.
- For this steering design, we need four tie rods. One, shown in the third picture, to go from the Pitman arm to the main steering linkage. You need one for each side to go from the spindle to the frame, and a third to connect each side's tie rods together.
- All tie rods are tapped 3/8-24RH on one end and 3/8-24LH on the other
- You may buy tie rods from suppliers like Azusa or McMaster-Carr. They cost a lot compared to the cost of raw materials, but they'll save you time.

Step 23 — Steering: bringing it all together


- This is another operation where good planning helps: In the first picture you can see that the steering area will be very cramped with your brake pedal and the suspension system.
- In the second picture you can see the Pitman arm tie rod connected to a swing arm. The swing arm rotates and also moves the right side tie rod going off to the right and the center tie rod going off to the left. Since the center tie rod won't have to articulate with the suspension, you can save some weight and cost by welding some 3/8-24 thread onto a nut.
- The third picture shows the left-hand swing arm with the center tie rod going to the right and the ball joint for the left-hand tie rod
- To adjust wheel center position, make the Pitman arm tie rods shorter or longer. To adjust toe-in/toe-out, make the center tie rod longer or shorter.
  - If you're feeling ambitious, you can adjust Ackerman geometry as well by playing with left-center-right length ratios.

Step 24 — Seat attachment

- Rather than drill/tap into the frame and risk weakening it, add extra stub members to attach your seat to.
- Pick at least four mounting places, preferably more, to attach your seat to.
- This may not sound important now, but drill a drain hole in your seat, especially if you plan on leaving your kart outside.
- Use screws rather than rivets to attach your seat. If you ever have to change something, you'll be glad you did.

Step 25 — Safety belts



- Quite possibly the most important part of the kart, safety belts will keep you secure relative to the kart whether on the road or in a crash.
  - Some prefer open karts with no belts so they are thrown clear in a crash. But if your kart wraps around or above your body, you must have belts to avoid getting tossed around in your own frame.
- Shoulder belts, though they may not come with mounting brackets like side belts, should be fixed so they can't move side-to-side. If they can move, they may slide off your shoulders. Keep them in place by restricting their movement.
- Note that my belts are attached to the tube, not the thin rod.
- Side and crotch belts should be attached to the frame as securely as possible. Weld a 1/2" bolt to the strong parts of the frame to ensure they don't go anywhere.

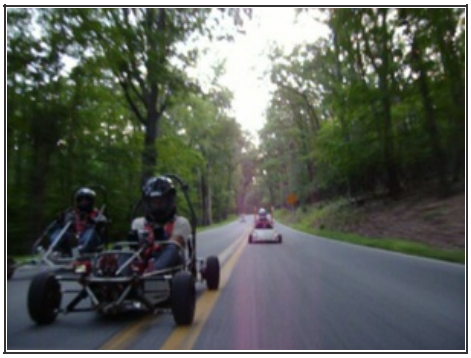
Step 26 — Underbody



- The underbody for this kart is a simple piece of sheet metal laid underneath the frame and bent straight up on either side of the body.
- The benefits of a one-piece construction are that there are no seams on the bottom of the kart to interfere with airflow or catch debris, there are fewer pieces to deal with, and you can get by with fewer attachment points on the bottom. Also, it looks nicer and prevents your feet from striking the ground at high speeds.
- Rather than drill holes right into your frame members and weakening them, weld tabs onto the frame and rivet or tap into those.

Step 27 — Finished!





- If you're in the Baltimore/DC area, come drive with the Maryland MISFITS soapbox group.
- Now drive off into the sunset! Downhill, of course, and make sure you have cameras recording. If you made your kart light enough, putting it on a car's roof rack should be a viable way to transport it.
- Please wear the proper safety gear when driving a kart like this. A good kart can reach or exceed highway speeds on gravity alone and doesn't have as much crumple room as your everyday car. A motorcycle helmet is an absolute must, with gloves, a neck brace, closed shoes, and tough clothing being highly recommended.
- For more build images, visit my Flickr photoset.
- for videos of this kart in action, see my Vimeo and Youtube pages.

Step 28 — Now, make it look pretty



- Even if it drives well and really moves, it won't be as satisfying until you put some paint on it and make it look like it deserves to go fast.
- If, like me, you waited too long to paint it, you'll have to break out the grinder, wire brush, sandblaster, etc. in order to get all the rust off.
- I recommend priming it with rusty-metal primer first.

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